PILOT SEAGRASS TRANSPLANTATION TRIALS IN FORSTERS BAY, NAROOMA, NSW

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SUMMARY

The last reported extent of seagrass coverage in the Wagonga Inlet, Narooma was given as 148 ha, although estimates of seagrass coverage vary considerably. The channel area consists of approximately 4 ha or 2.7% of this total coverage. The bare sand flats adjacent to the channel are naturally colonising at a reasonably rapid rate (c.a. 1 m y^{-1}). That seagrasses are healthy in the inlet is illustrated by the fact that they are growing successfully underneath jetties, boardwalks and oyster leases. Additionally, in the quite turbid environment of the upper reaches of the inlet, *Zostera* sp. is growing well. Any factor that would increase this turbidity such as runoff from land clearing would be expected to impact upon these communities and possibly reduce their range. However sediments in the channel between Mill and Forsters Bay are more coarse and turbidity caused by dredging would be expected to be short-lived; and, if carried out at the appropriate time of year would be expected to have minimal impact upon adjacent seagrasses.

After more than a year pilot seagrass transplantation trials on the sand flats adjacent to the channel have shown 92% survival. In addition there has been natural colonisation in this area by both seedlings and seagrass fragments within and around the transplant area. Recent data on transplantation trials in another NSW estuary have also shown good survival. This indicates that the seagrasses in the Narooma Inlet may neither be under stress nor are they decreasing in area and that seagrass transplantation may be a viable method to increase meadow area.

Dredging a channel would remove approximately 2.7 % of the seagrasses in the inlet adjacent to a seagrass meadow that is naturally colonising and of a greater size. The bare sand flat area is approximately 40 ha and might be expected to support at least half of this as seagrass meadows in the future. It would be possible to augment the colonisation by further transplantation of the appropriate methodology using material which would be dredged from the channel. Therefore if a channel is dredged to attract tourist boat usage during holiday periods, its total impact upon seagrass meadows in the inlet is likely to be minimal.

CONTENTS

1. INTRODUCTION

Wagonga Inlet, Narooma, NSW is an 'evolutionarily young' (Roy *et al.*, 2001) wave-dominated barrier estuary. There are approximately 148.4 ha of seagrasses comprised of populations of *Posidonia australis*, *Zostera* sp. and *Halophila* sp. (NSWDPWS, 2001, Roy *et al.*, 2001). A narrow channel on either side of the Princes Highway bridge connects Mill and Forsters Bay. This channel continues upriver to Peters Point, passing through a large shallow area approximately defined by a line connecting Peters Point to Shell Point and Shell Point to the NSW Fisheries boat ramp. The channel's location and past movement has been described as being quite restrictive to boating activities within the inlet. Anecdotal evidence suggests that this has considerably reduced tourist boat usage. Suggested solutions to increase amenity have included reshaping the channel/s to form more navigable waterways. As *Posidonia australis* meadows occur adjacent to the current channel, any reshaping is likely to impact upon them and concerns have been raised to ensure that the seagrasses are either protected or any losses properly mitigated. The seagrass area under potential impact comprises less than 2 ha, 1.3 % of the total seagrass coverage in the inlet, but a greater proportion of the *Posidonia australis* as the total seagrass coverage is comprised of three species. Several studies have focussed upon the Wagonga Inlet; NSWDPWS (2000) describes an investigation of the Narooma bar improvements, NSWDPWS (2001) investigates estuarine processes and a draft management plan and study was produced by Nelson Consulting Pty Ltd in March 2001 (Nelson Consulting, 2001). West *et al.*, (1985) also contains fisheries-oriented information and a map showing macrophyte distribution.

Currently in NSW there is no specific legislation designed to protect seagrasses, but as noted on the NSW Fisheries web site (http://www.fisheries.nsw.gov.au/conservation/habitats/seagrasses.htm): "What is left of the seagrass beds of NSW is a valuable resource that must be urgently protected. Any activity that is likely to affect important fish habitats such as seagrass beds must be referred to NSW Fisheries. Biologists examine the activities for ways of minimising the adverse effects. The NSW Fisheries document 'Estuarine Habitat Management Guidelines' describes measures being taken to protect valuable fish habitats.". The general view that seagrasses must be protected (apart from their intrinsic ecological value) has arisen from a perception that seagrasses do not regrow 'quickly' after their removal by physical means such as seismic blasting or dredging, chemical factors such as eutrophication and the limited success of transplantation efforts in NSW (Lord *et al.*, 1999). The persistence of such areas as the seismic holes in Jervis Bay and the perception that they have remained for some time has also contributed to a view of seagrass as a slow growing, relatively fragile, climax species.

To illustrate that some of these perceptions may be incorrect, it is valuable to examine more recent data from NSW, particularly that from Jervis Bay. In the late 1960s, 11 holes were blasted in a *Posidonia australis* meadow to aid in seismic testing for foundations for a proposed nuclear power plant. In 1972 the holes had an average diameter of 29.7 (± 1.1 se) m; in 1981 this had decreased to 24.6 (± 1.1 se) m and in 1993 it had reduced to 21.0 (± 1.3 se) m. The average growth rate of the meadows toward the centre of the holes was significantly different between the measurement periods, but between 1972 and 1993 it averaged 0.41 (± 0.03 se) m y^{-1}. In terms of area: the holes (in total) covered 7739 sq metres in 1972 and this had decreased to 3960 sq metres in 1993, in 21 years they had reduced to 51% of their original size. Data further suggest that the holes will have filled completely between the years 2007 and 2027, probably earlier. In summary, the holes in 1993 were half the size (i.e. area) they used to be, they are filling in at a rate of 0.3 to 0.6 m y^{-1} and will fill in the next decade. These estimates are lower than those suggested by Meehan and West (2000) who used linear growth rates towards the centre of meadows as opposed to areal spread used here. Several studies from NSW have also described what are considered to be slow rates of growth for the Jervis Bay area (West *et al.*, 1989; Meehan and West, 2000), although studies in other parts of

Australia suggest that seagrass spreading may be much more rapid (Paling and McComb, 2000) and rates of growth of over 1.0 m y^{-1} have been recorded (Paling, 1995). For comparison tropical species of seagrass such as *Cymodocea* sp. may grow at rates between 0.2 and 3.4 m y^{-1} (Duarte and Sand-Jensen, 1990).

Until recently the failure of seagrass transplantation efforts in NSW (and elsewhere in Australia) have also contributed to the perception that seagrass environments are fragile and unreturnable. Lord *et al.* (1999) reviewed seagrass transplantation efforts in Australia and concluded that most studies had major flaws in design and/or implementation of transplantation programmes rather than an inability of seagrasses to actually grow and spread once they were transplanted. A lack of consideration of water motion for example has resulted in many failures. In Western Australia storms and normal water motion are sufficient to remove 20 to 50 cm of sediment adjacent to seagrass beds (Paling *et al.*, 2000) and storms removed all of the 1800 transplants of seagrass planted by West *et al.* (1990) in Botany Bay. However Meehan and West (2002) recently noted success with *Posidonia australis* transplants in Port Hacking. Of the five sites they examined, two showed increases in shoot density, one remained static and two declined after several months. They concluded their data demonstrates that transplantation may be successful in increasing seagrass habitat in suitable areas. As with other researchers, they also concluded that successful seagrass rehabilitation is site specific and depends upon the removal of factors that contributed its decline in the first place. Such factors include eutrophication and sediment depth and stability.

Research in Western Australia has shown, despite earlier expectations, that seagrasses may be successfully transplanted under a variety of hydrological conditions. In exposed conditions it may be necessary to use large mechanically transplanted units of seagrass (Paling *et al.*, 2001; 2002), but in more sheltered areas smaller units of seagrass are able to survive and grow (Paling *et al.*, 2000; Tunbridge 2000). Wagonga Inlet would be expected to be relatively calm and thus any transplantation may also be able to utilise small scale manual transplant techniques.

The Marine and Freshwater Research Laboratory (MAFRL) were invited by the Eurosouth Community Group Inc. to investigate the feasibility of seagrass transplantation in the Wagonga Inlet to provide options in light of any suggested modifications to channels that may impact seagrasses. Specifically MAFRL was asked to address the following issues:

- Could *Posidonia australis* (or *Zostera* sp.) be transplanted within the Inlet and would it survive and grow (coalesce).
- If transplantation was successful, could this method be used to ameliorate seagrass removed through channel re-alignment.
- Was there evidence of *Posidonia australis* growth or regrowth in locations normally not considered suitable for seagrasses, for example under boardwalks or jetties and oyster leases.
- What was the distribution of seagrass within the inlet.

To address these issues, a brief survey of the seagrass distribution in the Wagonga Inlet was carried out, seagrass transplantation pilot trials were put in place and a presentation made to various community and government members. This document describes the results obtained and makes recommendations for future transplantation work if desired.

2. METHODS

Members of the Marine and Freshwater Research Laboratory (Paling and van Keulen) visited the Narooma region from 10th to 13th December 2001.

2.1 Surveys

A general survey of the seagrasses within the area oceanward of the Princes Highway bridge was made on the 10th December. A more specific survey was carried out upriver of the bridge to Punkally Creek on the 11th December. Seagrass distribution and species were noted on a base map from observations made from a boat and in the water using snorkel. Several oyster leases were investigated and data recorded photographically using a still camera and digital video. Oyster leases in operation were investigated to determine seagrass growth around and under the oyster frames. In addition, several disused oyster leases were investigated to determine the recovery of seagrasses after frame removal. The limit of survey was to just past Punkalley Creek when water depths precluded further investigation.

2.2 Transplant trials

The transplant method used is described in Paling *et al.* (2000). Plugs, which consisted of the whole plant, including leaf blades, roots, rhizome and the surrounding sediment intact, were extracted using 200 mm lengths of PVC piping (15 cm diameter). Piping bases were capped with plastic sewer lids to minimise rhizome and root disturbance. They were then carried to the transplant site, where holes were excavated to receive them. The PVC piping and the caps were removed when the plugs were planted. In an effort to minimise damage and disturbance to the donor meadow, plugs were removed at random. Material collection and planting was performed using snorkel and all plugs were replanted within five minutes of extraction. Twelve 15-cm diameter plugs (Figure 1) were extracted from a continuous *Posidonia australis* meadow (approximately 4 ha) in Forsters Bay and transplanted to bare sand (0.5 m) approximately 10 m south of it using snorkel. Transplants were placed in a loose grid formation approximately 0.5 m apart (Figure 3). Monitoring of survival and general health has been carried out on a monthly basis by Narooma community members (Teresa and John Van Der Heul) for the last 14 months.

3. RESULTS AND DISCUSSION

3.1 Surveys

The seagrass observed in the inlet was by and large healthy and consisted of those species noted in other studies carried out in the inlet. Estimates for the seagrass coverage in the Wagonga Inlet vary between studies (Table 1) and it was not the aim of this study to determine areal coverage. It is advised, given the 50% variation in estimates produced so far, that perhaps a consistent method be used to map the past and current distribution of seagrasses in the inlet.

Table 1: Different estimates of seagrass coverage in Wagonga Inlet. The two figures with an asterisk are derived from Meehan and West's study (in prep) using a consistent method of mapping (NSWDPWS, 2001).

Date	Seagrass Area (km^2)	Study
1957	*0.828	Meehan and West (in prep)
1974	1.717	Briggs *et al.*, 1980
1979	1.484	West *et al.*, 1985
1982	0.871	Meehan and West (in prep)
1994	*0.747	Meehan and West (in prep)

It was noted during the surveys that seagrasses occurred deeper than those values given in NSWDPWS (Table 7.1, 2001). Again it is recommended that a series of surveys be carried out to determine the true depth distribution of the seagrasses in these areas, possibly over seasons as these are likely to change.

More specifically, healthy *Posidonia australis* was observed growing adjacent to, and under, oyster leases (Figure 4). There was also marked regeneration within the oyster cage racks when the trays had been removed (Figure 5). Additionally, healthy seagrass was observed growing around and under the various jetties in the Wagonga Inlet (Figure 6). It has normally been considered that the presence of oyster leases impacts detrimentally on the seagrass beds in this inlet. This conclusion is not warranted given the observations made from this study.

3.2 Transplant trials

Transplant survival after more than a year was 92% (Figure 7). Survival was 100% for over half a year until the one unit that was hit by a boat propeller, a month after installation, was eventually lost (Table 2).

Table 2: Field observations of transplant health and survival summarised from Ms Van Der Heul.

Date	Day number	Years	Transplant number	Comments
12 Dec 2001	0	0	12	12 transplants installed
18 Jan 2002	37	0.10	12	11 healthy plants, 1 has been chopped by a propeller
16 Feb 2002	66	0.18	12	11 healthy plants, chopped plant is still present
11 Jun 2002	181	0.49	12	11 healthy plants, chopped plant is still present. Oyster farmer has planted lease pole in middle of nursery and placed rail over southern end of transplant area
1 Oct 2002	291	0.78	11	11 healthy plants, chopped plant gone. Meadow alongside has extended boundary towards nursery (i.e. the shallows) by ~ 20 cm.
29 Jan 2003	412	1.13	11	11 Healthy plants, meadow has extended 1.2 m toward transplant area.
11 Apr 2003	484	1.32	11	11 Healthy plants which are continuing to grow

These results are very encouraging. Meehan and West (2002) noted an overall combined survival of 113% at the five sites they examined. However this was caused by good growth of transplants at two sites, 78% survival at another and the other two sites lost all transplants after 10 months. It should be pointed out that the present study is a pilot trial. Meehan and West's (2002) study transplanted considerably more units (575).

4. CONCLUSIONS AND RECOMMENDATIONS

The channel area consists of approximately 4 ha or 2.7 % of this total coverage. The bare sand flats adjacent to the channel are naturally colonising at a reasonably rapid rate (ca 1 m y^{-1}). That seagrasses are healthy in the inlet is illustrated by the fact that they are growing successfully underneath jetties, boardwalks and oyster leases. Additionally, in the quite turbid environment of the upper reaches of the inlet, *Zostera* sp. is growing well. Any factor that would increase this turbidity such as runoff from land clearing would be expected to impact upon these communities and possibly reduce their range. Sediments in the channel between Mill and Forsters Bay however are more coarse and turbidity caused by dredging would be expected to be short-lived; and, if carried out at the appropriate time of year would be expected to have minimal impact upon adjacent seagrasses.

After more than a year pilot seagrass transplantation trials on the sand flats adjacent to the channel have shown 92% survival, this is very encouraging. In addition there has been natural colonisation in this area by both seedlings and seagrass fragments within and around the transplant area. Adjacent meadow growth has also been healthy and rapid. Recent data on transplantation trials in another NSW estuary have also shown good survival. This indicates that the seagrasses in the Narooma Inlet may neither be under stress nor are they decreasing in area and that seagrass transplantation may be a viable method to increase meadow area.

Dredging a channel would remove approximately 2.7 % of the seagrasses in the inlet adjacent to a seagrass meadow that is naturally colonising and of a greater size. The bare sand flat area is approximately 40 ha and might be expected to support at least half of this as seagrass meadows in the future. It would be possible to augment the colonisation by further transplantation of the appropriate methodology using material which would be dredged from the channel. Therefore if a channel is dredged to attract tourist boat usage during holiday periods, its total impact upon seagrass meadows in the inlet is likely to be minimal.

It may be valuable to commence further, more detailed transplant studies to ascertain the feasibility of mitigating for any seagrass loss caused by dredging or other activities such as jetty construction. Although further (small) pilot trials could be carried out in different areas it would be beneficial to conduct larger studies within a defined scientific framework. This would include rigorous documentation and photographic evidence of the transplant method, scenario, site layout and survival. The entire process should also be conducted in a scientifically and statistically valid way. This also implies long term monitoring. A properly executed and monitored exercise would be needed to convince regulatory authorities, the public and the wider community that success is indeed achievable. Additionally, proper documentation will assist Narooma (and other towns) in future developments along the coast. The authors would be pleased to be involved and to help disseminate the information in the widest forum possible, this also serves to further validate your work.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

Briggs, I., Carrick, N., Fisher, H., Milledge, D. and Williams E. (1980) A survey of the estuarine fauna of the Eurobodalla Shire, Report by the Australian Museum, Sydney, for the CSIRO Division of Land Use Research.

Duarte, C.M., and Sand-Jensen, K., 1990. Seagrass colonization: patch formation and growth in Cymodocea nodosa. Mar. Ecol. Progr. Ser. 65, 193-200.

Lord, D.; Paling, E.; Gordon, D. (1999): Review of Australian rehabilitation and restoration programs. Chap. 3. In: Seagrass in Australia. Strategic review and development of an R & D plan. (Eds: Butler, A.J.; Jernakoff, P.) CSIRO Publishing, Collingwood, Vic, 65-115.

Meehan A.J. and West R.J. (2000) Recovery times for a damaged *Posidonia australis* bed in south eastern Australia. Aquatic Botany 67;161–167.

Meehan A.J. and West R.J. (2002) Experimental transplanting of *Posidonia australis* seagrass in Port Hacking, Australia, to assess the feasibility of restoration. Marine Pollution Bulletin. 44;25-31.

Meehan A.J. and West R.J. (in prep) Historical changes in seagrass communities in four barrier estuaries in south-eastern Australia.

Nelson Consulting Pty Ltd (2001) Wagonga Inlet: Estuary Management Study and Plan. Draft. Nelson Consulting Pty Ltd, Manly NSW.

NSWDPWS (2000) Investigation of Narooma Bar improvements. Report #MHL1037. NSW Department of Public Works and Services, Manly Hydraulics Laboratory.

NSWDPWS (2001) Wagonga Inlet Estuary Processes Study. Report #MHL1011. NSW Department of Public Works and Services, Manly Hydraulics Laboratory.

Paling, E.I. (1995): Seagrass meadow regrowth, transplantation and recovery after disturbance in Western Australia: a review. Marine and Freshwater Laboratory, Murdoch University, Perth. 42 pages.

Paling E.I. and McComb A.J. (2000) Autumn biomass, below ground productivity, rhizome growth at bed edge and nitrogen content in some seagrasses from Western Australia. Roy P.S., R.J. Williams, A.R. Jones, I. Yassini, P.J. Gibbs, B. Coates, R.J. West, P.R. Scanes, J.P. Hudson and S. Nichol (2001) Structure and Function of South-east Australian Estuaries. Estuarine, Coastal and Shelf Science. 53, 351–384.

Paling, E.I.; van Keulen, M.; Wheeler, K.; Walker, C. (2000): The effects of depth on manual transplantation of the seagrass *Amphibolis griffithii* (J.M. Black) den Hartog on Success Bank, Western Australia. Pacific Cons. Biol. 5(3), 314-320.West R.J., Thorogood C., Walford T. and Williams R.J. (1985) An estuarine inventory for New South Wales, Australia. Fisheries Bulletin 2. Department of Agriculture, NSW.

Paling, E.I.; van Keulen, M.; Wheeler, K.; Phillips, J.; Dyhrberg, R., Lord, D.A. (2001) Improving mechanical seagrass transplantation. Ecological Engineering 18; 107-113

Paling, E.I., van Keulen, M., Wheeler K. (2002) Seagrass rehabilitation on Success bank, Western Australia (Project S2, 1995-2002). (Project S2, 1995-2002): Final Report. (Marine and Freshwater Research Laboratory, Murdoch, Western Australia)

Tunbridge, D. (2000) Seagrass transplant studies in Cockburn Sound. Honours Thesis, Environmental Science, Murdoch University. Perth, Western Australia.

West, R.J., Thorogood, C.A., Walford, T.R. and Williams R.J. (1985) An estuarine inventory for NSW, Australia. Fisheries Bulletin 2, Department of Agriculture NSW.

West, R.J., Larkum, A.W.D., King, R.J., 1989. Regional studies - seagrasses of south eastern Australia. In: A.W.D. Larkum, A.J. McComb, S.A. Shepherd (Eds), Biology of Seagrasses: A Treatise on the Biology of Seagrasses with Special Reference to the Australian Region. Elsevier, Amsterdam, pp 230-260.

West, R.J., Jacobs, N.E., Roberts, D.E., 1990. Experimental transplanting of seagrasses in Botany Bay, Australia. Mar. Poll. Bull. 21, 197-203.

7. FIGURES

Figure 1: Transplant units used in Forsters Bay.

Figure 2: Aerial photograph showing location of transplants in Forsters Bay

Figure 3: Transplants located approximately 10 m south of donor meadow.

Figure 4: *Posidonia australis* growing around oyster leases in the Wagonga Inlet.

Figure 5: *Posidonia australis* regenerating after cages have been removed in Wagonga Inlet.

Figure 6: *Posidonia australis* growing adjacent to and under the Ringlands Point jetty.

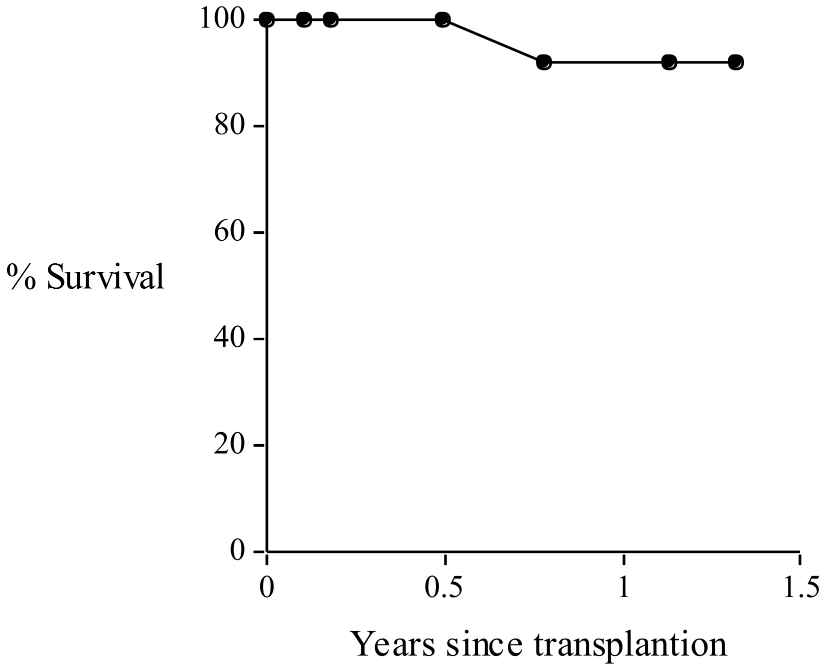

Figure 7: Percent survival of 12 *Posidonia australis* transplants placed in the Wagonga Inlet.